Claims

[c1] 1.A coated ferromagnetic particle comprising a ferromagnetic core and a coating, said coating comprising a residue resulting from a thermal treatment of a coating material comprising a polymer selected from the group consisting of polyorganosiloxanes, polyorganosilanes, and mixtures thereof.

[c2] 2.The coated ferromagnetic particle of claim 1, wherein said ferromagnetic core comprises a material selected from the group consisting of Fe and Fe alloys.

[c3] 3.The coated ferromagnetic particle of claim 2, wherein said ferromagnetic core has an average diameter in a range from about 10 micrometers to about 1 millimeter.

[c4] 4.The coated ferromagnetic particle of claim 1, wherein said polymer comprises a silicone polymer.

[c5] 5.The coated ferromagnetic particle of claim 1, wherein said coating material has a weight in a range from about 0.05 weight percent to about 1 weight percent of a total weight of said ferromagnetic core and said coating material.

[c6] 6.A composite magnetic article comprising a compacted and annealed article of a desired shape comprising a plurality of coated ferromagnetic particles each comprising a ferromagnetic core and a coating, said coating comprising a residue resulting from a thermal treatment of a coating material comprising a polymer selected from the group consisting of polyorganosiloxanes, polyorganosilanes, and mixtures thereof.

[c7] 7.The composite magnetic article of claim 6, wherein said ferromagnetic core comprises a material selected from the group consisting of Fe and Fe alloys.

[c8] 8.The composite magnetic article of claim 7, wherein said ferromagnetic core has an average diameter in a range from about 10 micrometers to about 1 millimeter.

[c9] 9.The composite magnetic article of claim 6, wherein said polymer comprises a silicone polymer.

[c10] 10.The composite magnetic article of claim 6, wherein said coating material has a weight in a range from about 0.05 weight percent to about 1 weight percent of a total weight of said ferromagnetic core and said coating material.

[c11] 11.The composite magnetic article of claim 6, wherein said composite article has a transverse rupture strength greater than about 100 MPa.

[c12] 12.The composite magnetic article of claim 6, wherein said composite magnetic article has a magnetic permeability greater than about 250 at a magnetic flux density of about 1 Tesla and a frequency of about 60 Hz.

[c13] 13.The composite magnetic article of claim 6, wherein said composite magnetic article has a core loss of less than about 35 W/kg at a magnetic flux density of about 1 Tesla and a frequency of about 60 Hz.

[c14] 14.A method for making a coated ferromagnetic particle, said method comprising the steps of:

a.providing an uncoated ferromagnetic core;

b.providing a coating material comprising a polymer selected from the group consisting of polyorganosiloxanes, polyorganosilanes, and mixtures thereof;

c.encapsulating said uncoated ferromagnetic core with said coating material comprising said polymer; and

d.thermally treating said coating material so as to convert said coating material into a residue;

to produce said coated ferromagnetic particle.

[c15] 15.The method of claim 14, wherein said ferromagnetic core comprises a material selected from the group consisting of Fe and Fe alloys.

[c16] 16.The method of claim 15, wherein said ferromagnetic core has an average diameter in a range from about 10 micrometers to about 1 millimeter.

[c17] 17.The method of claim 14, wherein said polymer comprises a silicone polymer.

[c18] 18.The method of claim 14, wherein said coating material has a weight in a range from about 0.05 weight percent to about 1 weight percent of a total weight of said ferromagnetic core and said coating material.

[c19] 19.The method of claim 14, wherein the step of thermally treating said coating material is performed at a temperature greater than about 250 ^{o} C.

[c20] 20.A method for producing a composite magnetic article, said method comprising the steps of:

a.providing uncoated ferromagnetic particles;

b.providing a coating material comprising a polymer selected from the group consisting of polyorganosiloxanes, polyorganosilanes, and mixtures thereof;

c.encapsulating each of said uncoated ferromagnetic particles with said coating material comprising said polymer to produce encapsulated ferromagnetic particles;

d.subjecting said encapsulated ferromagnetic particles to a compaction to form a compact of a desired shape; and

e.subjecting said compact to an annealing treatment;

to produce said composite magnetic article, wherein said composite magnetic article comprises a plurality of coated ferromagnetic particles wherein each particle comprises a ferromagnetic core and a coating, said coating comprising a residue resulting from a thermal treatment of said coating material comprising said polymer.

[c21] 21.The method of claim 20, wherein said ferromagnetic core comprises a material selected from the group consisting of Fe and Fe alloys.

[c22] 22.The method of claim 21, wherein said ferromagnetic core has an average diameter in a range from about 10 micrometers to about 1 millimeter.

[c23] 23.The method of claim 20, wherein said polymer comprises a silicone polymer.

[c24] 24.The method of claim 20, wherein said coating material has a weight in a range from about 0.05 weight percent to about 1 weight percent of a total weight of said ferromagnetic core and said coating material.

[c25] 25.The method of claim 20, wherein said annealing treatment is performed at an annealing temperature greater than about 400 ^{o} C.

[c26] 26.The method of claim 25, wherein said annealing treatment is performed at

said annealing temperature in a range from about 450 ^{o} C to about 950 ^{o} C.

[c27] 27.The method of claim 26, wherein said annealing treatment is performed for an annealing time in a range from about one minute to about ten hours.

[c28] 28.The method of claim 20, wherein said annealing treatment comprises a first annealing treatment and a second annealing treatment wherein said first annealing treatment is performed at at least a first annealing temperature for a first annealing time followed by said second annealing treatment performed at at least a second annealing temperature for a second annealing time.

[c29] 29.The method of claim 28, wherein said first annealing temperature is in a range from about 450 ^{o} C to about 950 ^{o} C; said first annealing time is in a range from about one minute to about ten hours; said second annealing temperature is in a range from about 300 ^{o} C to about 600 ^{o} C; and said second annealing time is greater than about one minute.

[c30] 30.The method of claim 20, wherein said compaction is performed using a compaction pressure in a range from about 250 MPa to about 1300 MPa.

[c31] 31.The method of claim 20, wherein said compact is subjected to a decomposition treatment prior to said annealing treatment.

[c32] 32.The method of claim 31, wherein said compact is subjected to said decomposition treatment at a temperature of greater than about 250 ^{o} C for more than about one minute.

[c33] 33.The method of claim 20, wherein said composite magnetic article has a transverse rupture strength greater than about 100 MPa.

[c34] 34.The method of claim 20, wherein said composite magnetic article has a magnetic permeability greater than about 250 at a magnetic flux density of about 1 Tesla and a frequency of about 60 Hz.

[c35] 35.The method of claim 20, wherein said composite magnetic article has a core loss of less than about 35 W/kg at a magnetic flux density of about 1 Tesla and a frequency of about 60 Hz.

[c36] 36.The method of claim 20, wherein the step of encapsulating each of said uncoated ferromagnetic particles is done by a process selected from the group consisting of a dip coating process, a spray coating process, a fluidized bed coating process, and a precipitation coating process.

[c37] 37.A device using electromagnetic materials comprising the composite magnetic article of claim 6.

[c38] 38.The device of claim 37, selected from a group consisting of stators, rotors, solenoids, cores for transformers, inductors, actuators, MRI pole faces, and MRI shims.